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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary

Application No.

10/849,964

Applicant(s)

RAMANATHAN ET AL.

Examiner

BACH T. DINH

Art Unit

1795

Period for Reply -- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 26 February 2010.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 6, 8-11 and 21-25 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 6, 8-11 and 21-25 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO/SB-06)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: _____

DETAILED ACTION

Summary

1. This is the response to the communication filed 02/26/2010.
2. Claims 6, 8-11 and 21-25 remain pending in the application.
3. The application is not in condition for allowance.

Claim Rejections - 35 USC § 103

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
 2. Ascertaining the differences between the prior art and the claims at issue.
 3. Resolving the level of ordinary skill in the pertinent art.
 4. Considering objective evidence present in the application indicating obviousness or nonobviousness.
6. Claims 6 and 8-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Khan et al. (US 7,038,312) in view of Chu et al. (US 6,804,966), Rabin et al. (WO 03/046265) and Ghoshal (US 6,256,996). Ghoshal is cited and relied on for the first time in this office action. Its use is necessitated by Applicant's amendment to the claims.

Addressing claim 6 and 8-10, Khan discloses an electronic package, comprising:

A microelectronic die (102, figure 1B) having at least one area of which is of a higher heat dissipation rate than the remainder of the microelectronic die when in operation (figure 2B, area 202 is the die mounting position with the center area being the area with the highest temperature or the area with a higher heat dissipation rate than the remainder of the microelectronic die);

Furthermore, Khan discloses stiffener 112 is coupled to the electronic die 102 for heat spreading purpose (6:16-17, figure 1B) and the stiffener 112 is made of copper, tin or aluminum (6:13-15). Moreover, the temperature profile in figure 2B shows that the center area has the highest temperature, which is concentrically surrounded by areas with successively lower temperatures. Overall, figure 2B shows at least 4 areas with different temperatures that concentrically surrounding each other, with the center area being the claimed area of higher heat dissipation rate and the area adjacent to the center area with lower temperature is claimed intermediate area. Both of the higher heat dissipation area and the intermediate area are concentrically surrounded by areas of even lower temperatures.

Khan is silent regarding a first electrode proximate to the microelectronic die, a dielectric material proximate to the first electrode, a second electrode opposing the first electrode with the dielectric material disposed therebetween, a plurality of nano-wires extending between the first and second electrode with the density of the nano-wires being arranged in the configuration as required by current claim and an isolation layer formed on the microelectronic die having a thickness of between about 0.1 and 1.0 micron.

Rabin discloses a thermoelectric cooling device (figures 8-9); wherein, the thermoelectric cooling device comprises of:

A first electrode proximate the higher heat area (high temperature electrode 260);

A dielectric material proximate the first electrode (porous alumina body 220, 13:26-31);

A second electrode opposing the first electrode with the dielectric material disposed therebetween (electrodes 230); and

A plurality of nano-wires extending between the first electrode and the second electrode (p-type and n-type bismuth containing nanowires 222 and 224, 9:25-31, 13:32-14:2).

Chu discloses a thermoelectric package (figures 1-3B), comprising:

A microelectronic die (electronic device 12) having at least one area of which is of a higher heat dissipation rate than the remainder of the microelectronic die when in operation (figures 2A-2C, high heat flux area 13 and the remaining lower heat flux area of device 12);

A plurality of thermoelectric elements disposed at highest density in the high heat flux area 100A and 100B and lower density at the low heat flux area 110 (figures 3A-3B, 6:40-67).

At the time of the invention, one with ordinary skill in the art would have found it obvious to modify the electronic package of Khan with coupling the thermoelectric package of Rabin to the electronic die 102 of Khan in the manner disclosed by Chu because Chu discloses that it is conventional in the art to use a thermoelectric package for

controlling the temperature of an electronic die and the thermoelectric package of Rabin is capable of spreading heat from one area to another (Rabin, 12:20-13:7) as well as converting heat to electrical energy, thus functioning as an additional power generator (Rabin, 13:18-25). According to the disclosure of Chu, where the density of the thermoelectric elements is arranged according to the temperature profile of the electronic die, one would have found it obvious to arrange the nano-wires of Rabin with the highest density proximate to the center area of Khan's electronic die with the highest temperature, follow by surrounding the center area with a lower density of nano-wires proximate to the intermediate area, a further lower density of the nano-wires proximate to the area surrounding the intermediate area and an absence of nano-wires proximate to the remainder of the microelectronic die because doing so would provide more uniform temperature distribution across the electronic device as well as improving the energy consumption efficiency of the thermoelectric package (Chu, 7:1-13).

Khan, Rabin and Chu are silent regarding the nano-wires being arranged in concentric ovals as required by current claim. However, it does not appear that the concentric ovals arrangement is critical to the instant application for such concentric ovals arrangement is designed to match the temperature profile of the electronic die (figure 13 of current application); furthermore, Chu already discloses the method of arranging the density of the nano-wires to match the temperature profile of an electronic die as addressed above. Therefore, the arrangements of the nano-wires are selectable variables of which the selection of shape would be within the technical grasp of an ordinary artisan based on the size, shape and the location of the intended installation/application. Thus, absent

contrary support for the criticality of the claimed concentric ovals arrangement, it would have been a matter of obviousness to a person having ordinary skill in the art at the time of the invention to vary/select the shape of the arrangement of the nano-wires in the thermoelectric package of Khan, Chu and Rabin (see MPEP 2144.04{IV} {B}).

Ghoshal discloses a sub-micron nanoscopic thermoelectric coolers; wherein, the thermoelectric module comprises a layer of electrically insulating silicon dioxide material (layer 206 in figure 2A, 3:50-51; or layer 306 in figure 3A, 4:27-29; furthermore, "sub-micron" implies that the dimensions of thermoelectric module including the silicon dioxide material are smaller than one micron). Additionally, the sub-micron thermoelectric module, including the silicon dioxide layer, is disposed on the integrated circuit (IC) layer in figure 5; therefore, when the thermoelectric module is mounted on the IC layer, the silicon dioxide layer is disposed between the electrodes of the thermoelectric module and the IC layer.

At the time of the invention, one with ordinary skill in the art would have found it obvious to modify the thermoelectric package of Khan and Rabin with the sub-micron silicon dioxide layer of Ghoshal in the manner disclosed in figure 5 because the sub-micron silicon dioxide layer would provide thermal conduction and electrical insulation between the microelectronic die and the thermoelectric module (Ghoshal, 3:53-56). With respect to the thickness of the isolation layer, Ghoshal already discloses that the silicon dioxide layer is sub-micron; therefore, absence contrary support to show criticality, one would have arrived at the claimed thickness of about 0.1 to 1.0 micron of the isolation

layer when perform routine experimentation with the thickness of the silicon dioxide in order to provide a sub-micron thermoelectric module for the microelectronic die.

Addressing claim 11, Rabin discloses a negatively charged trace electrically connected to the first electrode (for cooling function as described in figure 8A, the negatively charged p-type nanowires 222 are connected to the electrode 260) and a positively charged trace to the second electrode (in figure 8A, the n-type nanowires 224 are positively charged, 12:29-13:7).

7. Claims 21-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over O'Connor et al. (US 2002/0145194) in view of Khan et al. (US 7,03,312), Rabin et al. (WO 03/046265), Chu et al. (US 6,804,966) and Ghoshal et al. (US 6,256,996).

Addressing claims 21-24, Addressing claims 21-24, O'Connor discloses an electronic system (figure 1), comprising:

An external substrate within a housing (circuit board of the electronic assembly within a housing for computers, wireless communication devices or entertainment devices, 1:12-27); and

At least one microelectronic device package (integrated circuit package disclosed in figures 3a-3c) attached the external substrate (integrated circuit is physically and electrically coupled to the circuit board, 1:12-27). In figures 3a-3c, O'Connor discloses the integrated circuit package includes a die 40 comprises of a heat spreading layer 100,

which can be made of nanotubes (6:45-47), and the heat spreading layer must be thermally connected to the areas of the die that will generate the most heat [0042];

An input device interfaced with the external substrate (figure 1, keyboard/controller 20);

A display device interfaced with the external substrate (figure 1, display 8);

All the components are interfaced via a system bus 2; and

In figure 7a, O'Connor also discloses the microelectronic die 40 has area of highest heat dissipation rate (100-110 °C), areas of intermediate heat dissipation rate (90-100°C) surrounding the area of highest heat dissipation rate, an area of lower heat dissipation rate (80-90 °C) surrounding the area of intermediate heat dissipation rate, and an area of even lower heat dissipation rates or the remainder of the microelectronic die surrounding the area of lower heat dissipation rate (80-90 °C).

O'Connor is silent regarding a first electrode proximate to the microelectronic die, a dielectric material proximate to the first electrode, a second electrode opposing the first electrode with the dielectric material disposed therebetween, a plurality of nano-wires extending between the first and second electrode with the density of the nano-wires being arranged in the configuration as required by current claim and an isolation layer formed on the microelectronic die having a thickness of between about 0.1 and 1.0 micron.

Khan discloses a microelectronic die (102, figure 1B) having at least one area of which is of a higher heat dissipation rate than the remainder of the microelectronic die when in operation (figure 2B, area 202 is the die mounting position with the center area being the area with the highest temperature or the area with a higher heat dissipation rate than the

remainder of the microelectronic die). Moreover, the temperature profile in figure 2B shows that the center area has the highest temperature, which is concentrically surrounded by areas with successively lower temperatures. Overall, figure 2B shows at least 4 areas with different temperatures that concentrically surrounding each other, with the center area being the claimed area of higher heat dissipation rate and the area adjacent to the center area with lower temperature is claimed intermediate area. Both area of higher heat dissipation and the intermediate area are concentrically surrounded by areas of even lower temperatures.

Rabin discloses a thermoelectric cooling device (figures 8-9); wherein, the thermoelectric cooling device comprises of:

A first electrode proximate the higher heat area (high temperature electrode 260);

A dielectric material proximate the first electrode (porous alumina body 220, 13:26-31);

A second electrode opposing the first electrode with the dielectric material disposed therebetween (electrodes 230); and

A plurality of nano-wires extending between the first electrode and the second electrode (p-type and n-type bismuth containing nanowires 222 and 224, 9:25-31, 13:32-14:2).

Chu discloses a thermoelectric assembly; wherein, the density of the thermoelectric elements is adjusted according to the degree of heat flux at different area of an integrated circuit chip 12 (figures 3A-3B, 6:40-67, denser thermoelectric elements in higher heat

flux areas 100A and 100B and less dense thermoelectric elements at area of lower heat flux 110).

At the time of the invention, one with ordinary skill in the art would have found it obvious to modify the electronic package of O'Connor with the microelectronic die of Khan because the microelectronic die of Khan has improved heat spreading capabilities as well as providing high levels of IC electrical performance (Khan, 2:22-24).

Furthermore, one with ordinary skill in the art would have found it obvious to modify the microelectronic die of Khan with coupling the thermoelectric package of Rabin to the microelectronic die 102 in the manner disclosed by Chu because Chu discloses that it is conventional in the art to use a thermoelectric package for controlling the temperature of an electronic die and the thermoelectric package of Rabin is capable of spreading heat from one area to another (Rabin, 12:20-13:7) as well as converting heat to electrical energy, thus functioning as an additional power generator (Rabin, 13:18-25). According to the disclosure of Chu, where the density of the thermoelectric elements is arranged according to the temperature profile of the electronic die, one would have found it obvious to arrange the nano-wires of Rabin with the highest density proximate to the center area of Khan's electronic die with the highest temperature, followed by surrounding the center area with a lower density of nano-wires proximate to the intermediate area, a further lower density of the nano-wires proximate to the area surrounding the intermediate area and an absence of nano-wires proximate to the remainder of the microelectronic die because doing so would provide more uniform

temperature distribution across the electronic device as well as improving the energy consumption efficiency of the thermoelectric package (Chu, 7:1-13).

O'Connor, Khan, Rabin and Chu are silent regarding the nano-wires being arranged in concentric ovals as required by current claim. However, it does not appear that the concentric ovals arrangement is critical to the instant application for such concentric ovals arrangement is designed to match the temperature profile of the electronic die (figure 13 of current application); furthermore, Chu already discloses the method of arranging the density of the nano-wires to match the temperature profile of an electronic die as addressed above. Therefore, the arrangements of the nano-wires are selectable variables of which the selection of shape would be within the technical grasp of an ordinary artisan based on the size, shape and the location of the intended installation/application. Thus, absent contrary support for the criticality of the claimed concentric ovals arrangement, it would have been a matter of obviousness to a person having ordinary skill in the art at the time of the invention to vary/select the shape of the arrangement of the nano-wires in the thermoelectric package of Khan, Chu and Rabin (see MPEP 2144.04{IV}{B}).

Ghoshal discloses a sub-micron nanoscopic thermoelectric coolers; wherein, the thermoelectric module comprises a layer of electrically insulating silicon dioxide material (layer 206 in figure 2A, 3:50-51; or layer 306 in figure 3A, 4:27-29; furthermore, "sub-micron" implies that the dimensions of thermoelectric module including the silicon dioxide material are smaller than one micron). Additionally, the sub-micron thermoelectric module, including the silicon dioxide layer, is disposed on the integrated

circuit (IC) layer in figure 5; therefore, when the thermoelectric module is mounted on the IC layer, the silicon dioxide layer is disposed between the electrodes of the thermoelectric module and the IC layer.

At the time of the invention, one with ordinary skill in the art would have found it obvious to modify the thermoelectric package of O'Connor, Khan and Rabin with the sub-micron silicon dioxide layer of Ghoshal in the manner disclosed in figure 5 because the sub-micron silicon dioxide layer would provide thermal conduction and electrical insulation between the microelectronic die and the thermoelectric module (Ghoshal, 3:53-56). With respect to the thickness of the isolation layer, Ghoshal already discloses that the silicon dioxide layer is sub-micron; therefore, absence contrary support to show criticality, one would have arrived at the claimed thickness of about 0.1 to 1.0 micron of the isolation layer when perform routine experimentation with the thickness of the silicon dioxide in order to provide a sub-micron thermoelectric module for the microelectronic die.

Addressing claim 25, Rabin discloses a negatively charged trace electrically connected to the first electrode (for cooling function as described in figure 8A, the negatively charged p-type nanowires 222 are connected to the electrode 260) and a positively charged trace to the second electrode (in figure 8A, the n-type nanowires 224 are positively charged, 12:29-13:7).

8. Claims 6, 8-11 and 21-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over O'Connor et al. (US 2002/0145194) in view of Rabin et al. (WO 03/046265) and Chu et al. (US 6,804,966).

Addressing claim 6 and 8-10, O'Connor discloses a thermoelectric package (figures 3a-3c), comprising:

A microelectronic die (die 40) having at least one area of which is of a higher heat dissipation rate than the remainder of the microelectronic die when in operation (figures 7a-7b); in figure 7a, O'Connor also discloses the microelectronic die 40 has area of highest heat dissipation rate (100-110 °C), which is surrounded by an area of intermediate heat dissipation rate (90-100°C), which is further surrounded by an area of lower heat dissipation rate (80-90°C), which is also surrounded by the remainder of the microelectronic die having lower temperature.

O'Connor further discloses the heat spreading layer of microelectronic die 40 is made up of nanotubes [0048] and the heat spreading layer must be thermally connected to the areas of the die that will generate the most heat [0042].

O'Connor is silent regarding a first electrode proximate to the microelectronic die, a dielectric material proximate to the first electrode, a second electrode opposing the first electrode with the dielectric material disposed therebetween, a plurality of nano-wires extending between the first and second electrode with the density of the nano-wires being arranged in the configuration as required by current claim and an isolation layer formed on the microelectronic die having a thickness of between about 0.1 and 1.0 micron.

Rabin discloses a thermoelectric cooling device (figures 8-9); wherein, the thermoelectric cooling device comprises of:

A first electrode proximate the higher heat area (high temperature electrode 260);

A dielectric material proximate the first electrode (porous alumina body 220, 13:26-31);

A second electrode opposing the first electrode with the dielectric material disposed therebetween (electrodes 230); and

A plurality of nano-wires extending between the first electrode and the second electrode (p-type and n-type bismuth containing nanowires 222 and 224, 9:25-31, 13:32-14:2).

Chu discloses a thermoelectric assembly; wherein, the density of the thermoelectric elements is adjusted according to the degree of heat flux at different area of an integrated circuit chip 12 (figures 3A-3B, 6:40-67, denser thermoelectric elements in higher heat flux areas 100A and 100B and less dense thermoelectric elements at area of lower heat flux 110).

At the time of the invention, one with ordinary skill in the art would have found it obvious to modify the device of O'Connor with the thermoelectric cooling device of Rabin because the cooling device of Rabin is capable of dissipating heat from one area to another (Rabin, 12:20-13:7) as well as converting heat to electrical energy, thus functioning as an additional power generator (Rabin, 13:18-25).

Furthermore, one would have found it obvious to modify the device of O'Connor by adjusting density of the thermoelectric elements according to the temperature profile of

the microelectronic die 40 of O'Connor in the manner disclosed by Chu because doing so would allow for lower circuit temperature for a given heat load to be established, provide a more uniform temperature distribution across the electronic device and improve the efficiency of the thermoelectric assembly (Chu, 7:5-13). Specifically, arranging the nano-wires with the higher density proximate to the area of higher temperature (100-110°C), surrounding the area of higher temperature with a lower density of nano-wires proximate to area of intermediate temperature (90-100°C) between the area of higher temperature (100-110 °C) and the remainder of the microelectronic die, surrounding the lower density area with a further lower density proximate to an area of lower temperature (80-90 °C), and an absence of nano-wires at the area of lowest temperature (50-60 °C), which is proximate to the remainder of the microelectronic die.

O'Connor, Rabin and Chu are silent regarding the nano-wires being arranged in concentric ovals as required by current claim. However, it does not appear that the concentric ovals arrangement is critical to the instant application for such concentric ovals arrangement is designed to match the temperature profile of the electronic die (figure 13 of current application); furthermore, Chu already discloses the method of arranging the density of the nano-wires to match the temperature profile of an electronic die as addressed above. Therefore, the arrangements of the nano-wires are selectable variables of which the selection of shape would be within the technical grasp of an ordinary artisan based on the size, shape and the location of the intended installation/application. Thus, absent contrary support for the criticality of the claimed concentric ovals arrangement, it would have been a matter of obviousness to a person

having ordinary skill in the art at the time of the invention to vary/select the shape of the arrangement of the nano-wires in the thermoelectric package of O'Connor, Chu and Rabin (see MPEP 2144.04{IV}{B}).

Ghoshal discloses a sub-micron nanoscopic thermoelectric coolers; wherein, the thermoelectric module comprises a layer of electrically insulating silicon dioxide material (layer 206 in figure 2A, 3:50-51; or layer 306 in figure 3A, 4:27-29; furthermore, "sub-micron" implies that the dimensions of thermoelectric module including the silicon dioxide material are smaller than one micron). Additionally, the sub-micron thermoelectric module, including the silicon dioxide layer, is disposed on the integrated circuit (IC) layer in figure 5; therefore, when the thermoelectric module is mounted on the IC layer, the silicon dioxide layer is disposed between the electrodes of the thermoelectric module and the IC layer.

At the time of the invention, one with ordinary skill in the art would have found it obvious to modify the thermoelectric package of O'Connor and Rabin with the sub-micron silicon dioxide layer of Ghoshal in the manner disclosed in figure 5 because the sub-micron silicon dioxide layer would provide thermal conduction and electrical insulation between the microelectronic die and the thermoelectric module (Ghoshal, 3:53-56). With respect to the thickness of the isolation layer, Ghoshal already discloses that the silicon dioxide layer is sub-micron; therefore, absence contrary support to show criticality, one would have arrived at the claimed thickness of about 0.1 to 1.0 micron of the isolation layer when perform routine experimentation with the thickness of the silicon

dioxide in order to provide a sub-micron thermoelectric module for the microelectronic die.

Addressing claim 11, Rabin discloses a negatively charged trace electrically connected to the first electrode (for cooling function as described in figure 8A, the negatively charged p-type nanowires 222 are connected to the electrode 260) and a positively charged trace to the second electrode (in figure 8A, the n-type nanowires 224 are positively charged, 12:29-13:7).

Addressing claims 21-24, O'Connor discloses an electronic system (figure 1), comprising:

An external substrate within a housing (circuit board of the electronic assembly within a housing for computers, wireless communication devices or entertainment devices, 1:12-27); and

At least one microelectronic device package (integrated circuit package disclosed in figures 3a-3c) attached the external substrate (integrated circuit is physically and electrically coupled to the circuit board, 1:12-27). In figures 3a-3c, O'Connor discloses the integrated circuit package includes a die 40 comprises of a heat spreading layer 100, which can be made of nanotubes (6:45-47), and the heat spreading layer must be thermally connected to the areas of the die that will generate the most heat [0042];

An input device interfaced with the external substrate (figure 1, keyboard/controller 20);

A display device interfaced with the external substrate (figure 1, display 8);

All the components are interfaced via a system bus 2; and

In figure 7a, O'Connor also discloses the microelectronic die 40 has area of highest heat dissipation rate (100-110 °C), areas of intermediate heat dissipation rate (90-100°C) surrounding the area of highest heat dissipation rate, an area of lower heat dissipation rate (80-90 °C) surrounding the area of intermediate heat dissipation rate, and an area of even lower heat dissipation rates or the remainder of the microelectronic die surrounding the area of lower heat dissipation rate (80-90 °C).

O'Connor is silent regarding a first electrode proximate to the microelectronic die, a dielectric material proximate to the first electrode, a second electrode opposing the first electrode with the dielectric material disposed therebetween, a plurality of nano-wires extending between the first and second electrode with the density of the nano-wires being arranged in the configuration as required by current claim and an isolation layer formed on the microelectronic die having a thickness of between about 0.1 and 1.0 micron.

Rabin discloses a thermoelectric cooling device (figures 8-9); wherein, the thermoelectric cooling device comprises of:

A first electrode proximate the higher heat area (high temperature electrode 260);

A dielectric material proximate the first electrode (porous alumina body 220, 13:26-31);

A second electrode opposing the first electrode with the dielectric material disposed therebetween (electrodes 230); and

A plurality of nano-wires extending between the first electrode and the second electrode (p-type and n-type bismuth containing nanowires 222 and 224, 9:25-31, 13:32-14:2).

Chu discloses a thermoelectric assembly; wherein, the density of the thermoelectric elements is adjusted according to the degree of heat flux at different area of an integrated circuit chip 12 (figures 3A-3B, 6:40-67, denser thermoelectric elements in higher heat flux areas 100A and 100B and less dense thermoelectric elements at area of lower heat flux 110).

At the time of the invention, one with ordinary skill in the art would have found it obvious to modify the device of O'Connor with the thermoelectric cooling device of Rabin because the cooling device of Rabin is capable of dissipating heat from one area to another (Rabin, 12:20-13:7) as well as converting heat to electrical energy, thus functioning as an additional power generator (Rabin, 13:18-25).

Furthermore, one would have found it obvious to modify the device of O'Connor by adjusting density of the thermoelectric elements according to the temperature profile of the microelectronic die 40 of O'Connor in the manner disclosed by Chu because doing so would allow for lower circuit temperature for a given heat load to be established, provide a more uniform temperature distribution across the electronic device and improve the efficiency of the thermoelectric assembly (Chu, 7:5-13). Specifically, arranging the nano-wires with the higher density proximate to the area of higher temperature (100-110°C), surrounding the area of higher temperature with a lower density of nano-wires proximate to area of intermediate temperature (90-100°C) between the area of higher

temperature (100-110 °C) and the remainder of the microelectronic die, surrounding the lower density area with a further lower density proximate to an area of lower temperature (80-90 °C), and an absence of nano-wires at the area of lowest temperature (50-60 °C), which is proximate to the remainder of the microelectronic die.

O'Connor, Rabin and Chu are silent regarding the nano-wires being arranged in concentric ovals as required by current claim. However, it does not appear that the concentric ovals arrangement is critical to the instant application for such concentric ovals arrangement is designed to match the temperature profile of the electronic die (figure 13 of current application); furthermore, Chu already discloses the method of arranging the density of the nano-wires to match the temperature profile of an electronic die as addressed above. Therefore, the arrangements of the nano-wires are selectable variables of which the selection of shape would be within the technical grasp of an ordinary artisan based on the size, shape and the location of the intended installation/application. Thus, absent contrary support for the criticality of the claimed concentric ovals arrangement, it would have been a matter of obviousness to a person having ordinary skill in the art at the time of the invention to vary/select the shape of the arrangement of the nano-wires in the thermoelectric package of O'Connor, Chu and Rabin (see MPEP 2144.04{IV}{B}).

Ghoshal discloses a sub-micron nanoscopic thermoelectric coolers; wherein, the thermoelectric module comprises a layer of electrically insulating silicon dioxide material (layer 206 in figure 2A, 3:50-51; or layer 306 in figure 3A, 4:27-29; furthermore, "sub-micron" implies that the dimensions of thermoelectric module including the silicon

dioxide material are smaller than one micron). Additionally, the sub-micron thermoelectric module, including the silicon dioxide layer, is disposed on the integrated circuit (IC) layer in figure 5; therefore, when the thermoelectric module is mounted on the IC layer, the silicon dioxide layer is disposed between the electrodes of the thermoelectric module and the IC layer.

At the time of the invention, one with ordinary skill in the art would have found it obvious to modify the thermoelectric package of O'Connor and Rabin with the sub-micron silicon dioxide layer of Ghoshal in the manner disclosed in figure 5 because the sub-micron silicon dioxide layer would provide thermal conduction and electrical insulation between the microelectronic die and the thermoelectric module (Ghoshal, 3:53-56). With respect to the thickness of the isolation layer, Ghoshal already discloses that the silicon dioxide layer is sub-micron; therefore, absence contrary support to show criticality, one would have arrived at the claimed thickness of about 0.1 to 1.0 micron of the isolation layer when perform routine experimentation with the thickness of the silicon dioxide in order to provide a sub-micron thermoelectric module for the microelectronic die.

Addressing claim 25, Rabin discloses a negatively charged trace electrically connected to the first electrode (for cooling function as described in figure 8A, the negatively charged p-type nanowires 222 are connected to the electrode 260) and a positively charged trace to the second electrode (in figure 8A, the n-type nanowires 224 are positively charged, 12:29-13:7).

Response to Arguments

9. Applicant's arguments with respect to claims 6, 8-11 and 21-25 have been considered but are moot in view of the new ground(s) of rejection.

Ghoshal is cited and relied on for the first time in this office action for the disclosure of a sub-micron electrically insulating silicon dioxide layer disposed between the electrodes of the thermoelectric module and the IC layer. Therefore, the limitations of current claims as amended are unpatentable for the reasons stated above.

Conclusion

10. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BACH T. DINH whose telephone number is (571)270-5118. The examiner can normally be reached on Monday-Friday EST 7:00 A.M-3:30 P.M.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam X. Nguyen can be reached on (571)272-1342. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Nam X Nguyen/
Supervisory Patent Examiner, Art Unit 1753

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